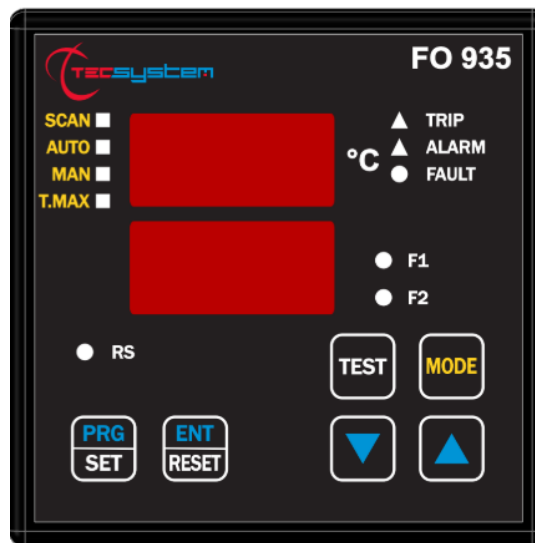


INSTRUCTION MANUAL

FO 935 D



1MN0224 REV.0



operates with ISO9001 certified quality system

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R. 1.3 16/04/24

ENGLISH

“Translations of the original instructions”

INTRODUCTION

First of all we wish to thank you for choosing to use a **TECSYSTEM** product and recommend you read this instruction manual carefully: You will understand the use of the equipment and therefore be able to take advantage of all its functions.

ATTENTION! THIS MANUAL IS ONLY VALID FOR THE VERSION FO 935 D.

TABLE OF CONTENTS

	PAGE
1) SAFETY REQUIREMENTS	4
2) ACCESSORIES	5
3) TECHNICAL SPECIFICATIONS	6
• FO 935 D	—
• CONC.CFO 521	8
• FO TEMPERATURE SENSORS	—
4) FO 935 FRONT PANEL	9
• DISPLAY	10
• OPERATING PROGRAM CONTROL	—
• NOTES ON SCAN AND MAN FUNCTIONS	—
• LED TEST	—
• ALARM RELAY TEST	—
• ALARM RELAY SILENCING	—
5) CFO 521 / FO SENSORS	11
• CFO 521 DIMENSIONS / INSTALLATION	—
• FO SENSORS DIMENSIONS / INSTALLATION	12
• CONNECTIONS OF THE CONC.CFO 521	—
• CFO 521 CONCENTRATOR OPERATION	13
6) FO 935 ASSEMBLY	14
7) ELECTRICAL CONNECTIONS	15
• FO 935 D BACK	—
• POWER SUPPLY	16
• ALARMS AND VENTILATION	—
• FAULT AND RESET MESSAGE SEQUENCE	17
• SENSOR DIAGNOSTICS CONC. CFO 521	—
• PROGRAMMED DATA DIAGNOSTICS	—
• TEMPERATURE DIAGNOSTICS	—

	PAGE
• COOLING FAN CONTROL	18
• FAN TEST	—
8) PROGRAMMING	19
• FO 935 D PROGRAMMING	—
• PROGRAMMING NOTES	21
9) FAIL SAFE FUNCTION	—
10) RS485 MODBUS	22
• INTRODUCTION TO THE MODBUS INSIDE MODULE	—
• OPERATING NOTES	—
• DATA TRANSMISSION ON MODBUS NETWORK	—
• RS485 ELECTRICAL CONNECTIONS	—
• DATA FRAME	—
• DATA PACKET	—
• FUNCTION CODE	23
• CODE 3(10).	—
• CODE 16(10).	—
• NOTES FOR REMOTE PROGRAMMING	—
• ERROR CODES	24
• UNACCEPTABLE DATA	—
• ILLEGAL DATA	—
• INTERROGATION FREQUENCY	—
• MODBUS MAPPING TABLE	25
11) WARRANTY REGULATIONS	30
12) TROUBLESHOOTING	—
13) EQUIPMENT DISPOSAL	—
14) USEFUL CONTACTS	31

SAFETY REGULATIONS



ATTENTION:

Read the manual carefully before starting to use the control unit. Keep the instructions for future reference.



Do not open the device. Touching any internal components can cause electric shock. Contact with a voltage over 50 Volts can be fatal. To reduce the risk of electric shock, do not dismantle the back of the device for any reason. Moreover its opening would void the warranty.



Before connecting the device to the power supply, make sure that all the connections are correct. Always disconnect the unit from the supply before any cabling modification. Any work on the equipment must be entrusted to a qualified engineer.

Failure to comply with these instructions can cause damage, fires or electric shock, and possible serious injuries!

POWER SUPPLY

The FO 935 control unit can be supplied by 85 to 260 Vdc-Vac, irrespectively of polarity in Vdc. Before using it, make sure the power cable is not damaged, knotted or pinched. Do not tamper with the power cable. Never disconnect the unit by pulling the cable and avoid touching the pins. Do not carry out any operations of connecting/disconnecting with wet hands. To disconnect the device, do not use objects such as levers. Immediately disconnect the device if you smell burning or see any smoke: contact assistance.

LIQUIDS

Do not expose the equipment to splashes or drops, do not position it in places with humidity exceeding 90% and never touch with wet or damp hands. If any liquid penetrates the control unit, disconnect it immediately and contact technical assistance.

CLEANING

Disconnect the power cable before cleaning the control unit, use a dry cloth to dust it, without any solvent or detergents, and compressed air.

OBJECTS

Never insert any objects into the cracks of the control unit. If this happens, disconnect the control unit and contact an engineer.

USE RESERVED TO QUALIFIED PERSONNEL

The purchased goods are a sophisticated electronic device that is completely unsuitable to be used by non-qualified personnel. Any work must be carried out by a specialist engineer.

ACCESSORIES

The use of non-original accessories or spare parts can damage the unit and endanger users' safety. In the event of faults, contact technical service.

LOCATION

Install the control unit indoors, in a place protected from water splashes and from the sun's rays. Do not place near heat sources exceeding the parameters stated in this manual. Position on a stable surface, far away from any possible vibrations. Position the unit as far away as possible from any intense magnetic fields.

REPAIRS

Do not open the control unit. For any fault, always use qualified personnel. The opening of the control unit and/or the removal of the series identifying label entails the automatic forfeiture of the warranty. The Warranty seal is applied to all devices, any attempt to open the unit would break the seal and cause the consequent automatic forfeiture of the warranty.

TECHNICAL INFORMATION OR REPORTING INFORMATION

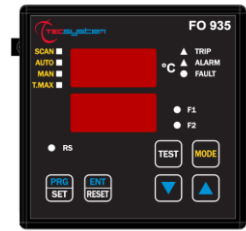
Mail: ufficiotecnico@tecsystem.it — **tel.:** 02/4581861

ACCESSORIES

The FO system boxes contain the following objects:

FO 935 control unit

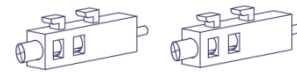
FO 935 control unit



Start guide and QR code



2 blocks for panel fixing



1 Terminal 3 pitch poles 5 supply
Code:2PL0367 - Screw tightening torque 0.5Nm



1 terminal 12 pitch poles 5 relays
Code:2PL0361 - Screw tightening torque 0.5Nm



1 Terminal 4 pitch poles 3.81 connection CFO 521
Code:2PL0368 - Screws tightening torque 0.25Nm

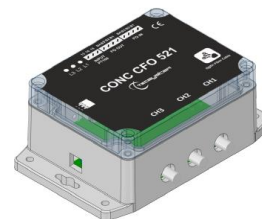


1 Terminal 3 pitch poles 3.81 RS485
Code:2PL0366 Screws tightening torque 0.25Nm



CFO 521 Concentrator

CFO 521 Concentrator



Start guide and QR code



2 Terminals 4 pitch poles 3.81 connection FO 935 and CFO 521
Code:2PL0368 - Screws tightening torque 0.25Nm



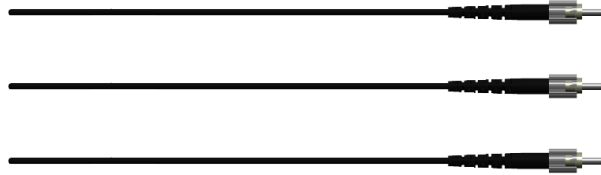
1 Terminal 3 poles pitch 3.81 Pt100 CH4
Code:2PL0366 - Screws tightening torque 0.25Nm



**ATTENTION: always install the device using the terminals included in the pack.
The use of terminals other than those included with the control unit could cause malfunctions.**

FO SENSORS

3 temperature sensors in fibre optic 2.5mt / 5mt



Start guide and QR code



TECHNICAL SPECIFICATIONS	FO 935 D
POWER SUPPLY	
Supply rated values	85-260 Vda-Vac 50/60HZ
Vdc with invertible polarities	•
INPUTS	
1 digital input (FO IN) connection CONC.CFO 521	•
Connections on removable terminal boards	•
OUTPUTS	
2 alarm relays (ALARM AND TRIP) SPDT	•
1 relay for faulty probes or operating anomaly (FAULT) SPST	•
2 ventilation management relays SPST FAN1 and FAN2	•
Output relays with 10A-250Vca-res COS Φ =1 contacts	•
RS485 Modbus RTU output	•
DIMENSIONS	
100x100 mm– din43700-prof .131mm (including terminal block)	Hole 92 x 92 mm

TECHNICAL SPECIFICATIONS

FO 935 D

TESTS AND PERFORMANCE

Construction in compliance with the EC regulations

•

Protection from electrical interferences EN 61000-4-4

•

Dielectric strength 1500 VAC for 1 min. between output relay and FO IN input, relay and power supply, and FO IN input and power supply

•

Reading range: -35°C to +195°C

•

Interface precision 1% vfs, ±1 digit

•

Ambient operating temperature from -20°C to +60°C

•

Permitted humidity 90% without condensate

•

Polycarbonate frontal film IP65

•

Container NORYL 94 _V0

•

Absorption 7.5VA

•

Self-diagnostic circuit

•

Electronic part protective treatment

Optional

DISPLAY AND DATA MANAGEMENT

2 x 13 mm displays with 3 digits to display temperatures, messages and channels

•

3 LEDs to display the state of the alarms of the selected channel (ALARM-TRIP-FAULT)

•

4 LEDs selection of display mode (SCAN-AUTO-MAN-T.MAX)

•

2 LEDs to display the state of FAN1 and FAN2

•

Temperature control from 1°C to 190°C (alarms)

•

2 alarm thresholds for channels 1-2-3

•

2 alarm channels for channel 4

•

2 ON-OFF thresholds FAN 1 and FAN 2 ventilation

•

FO sensor diagnostics (FCC-FOC-FLT)

•

Data memory diagnostics (Ech)

•

Communication diagnostics FO 935 to CFO 521 (TEC)

•

Access to programming through front keyboard

•

Automatic exit from programming, display and relay test after 1 minute of inactivity

•

Incorrect programming warning

•

Selection between channels automatic scanning, hottest channel or manual scanning (SCAN-AUTO-MAN)

•

Storage of maximum temperatures reached by channels and alarm status (TMAX)

•

Front key to reset the alarms

•

TECHNICAL SPECIFICATIONS**CONC. CFO 521****INPUTS**

1 FO 935 digital BUS input	FO IN
3 fibre optic FO sensor inputs (ST connectors)	CH1-CH2-CH3
1 2/3-wire Pt100 probe input	CH4

OUTPUTS

1 digital BUS output	FO OUT
----------------------	--------

TESTS AND PERFORMANCE

3 signalling LEDs L1-L2-L3	•
Work environment temperature	From -25°C to +60°C
Permitted humidity 90% without condensate	•
Degree of protection IP00	•
PC UL 94 HB container	•
Electronic part protective treatment	Optional

DIMENSIONS

145x106.7x55mm	•
Concentrator fixing bracket CONC. CFO 521	Included

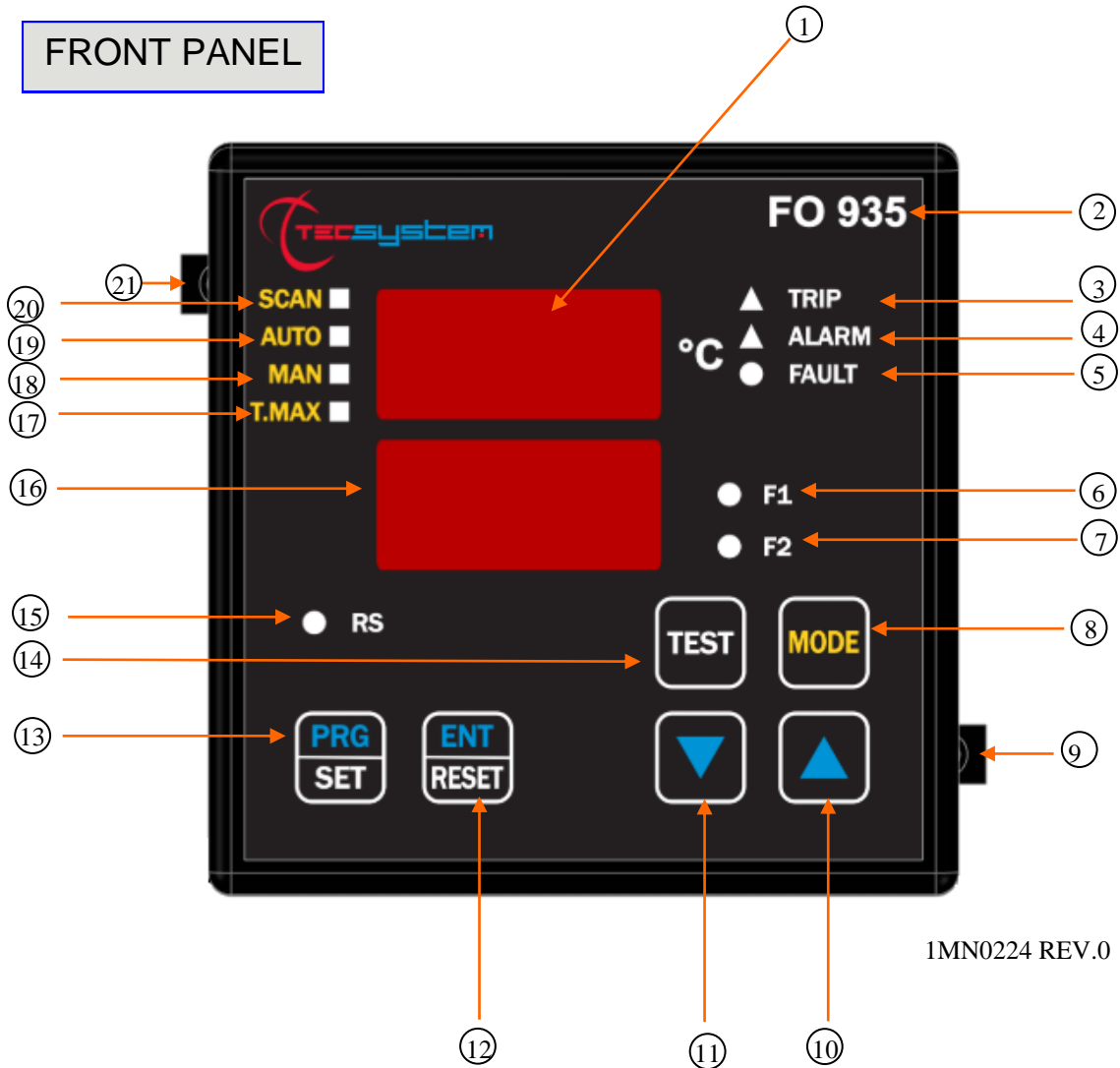
TECHNICAL SPECIFICATIONS**TEMPERATURE SENSOR
FO (FIBRE OPTIC)****TESTS AND PERFORMANCE**

Reading range	-35°C to +195°C
Interface precision	±1.0°C
Permitted humidity 90% without condensate	•
External protection	FEP
Working voltage	38 KV
AC withstand test	80 kVrms for 60 sec.
Lightning impulse withstand tests in air	150 kVpeak.

DIMENSIONS

Length	2.5mt / 5mt
Tip probe diameter	2.3mm
Fibre connector model	ST

FRONT PANEL



1MN0224 REV.0

1)	3-digit temperature display	12)	Enter/Reset button
2)	Control unit series	13)	Programming/Setting key
3)	TRIP signalling (red) LED	14)	Led/relay test key
4)	ALARM signalling (yellow) LED	15)	Modbus communication RS (green) LED
5)	FAULT signalling (red) LED	16)	3-digit channel display
6)	FAN 1 (yellow) LED	17)	T-max mode selection (red) LED
7)	FAN 2 (yellow) LED	18)	Man mode selection (yellow) LED
8)	Display mode selection key	19)	Auto mode selection (green) LED
9)	Fixing blocks	20)	Scan mode selection (yellow) LED
10)	UP key	21)	Fixing blocks
11)	DOWN key		

DISPLAY

The first display is dedicated to temperatures.

The second display to the monitored channel.

When the device is switched on or after a reset, the model of the control unit, the type of sensors, VER "00" (firmware version) and the temperature range of the device and the identification abbreviation are always shown on the display.

Pressing the MODE key, the display modes can be set:

- **SCAN:** the control unit shows in scanning (every 2 seconds) all the enabled (°C) and disabled (NO) channels.
- **AUTO:** the control unit displays the hottest channel automatically.
- **MAN:** manual reading of the channel temperature using the up/down keys ▲▼
- **T.MAX:** the display shows the maximum temperature of the channel selected with the cursor keys. In the event of a fault, the Tmax value is replaced with the type of fault stored (fcc-foc). Turning on the Trip Alarm-Fault LED warns of any events that have occurred. The recordings are always successive to the moment in which the T.Max is reset (by pressing RESET).

OPERATING PROGRAM CONTROL

To control the protection levels programmed, press the PRG key twice to access the **VIS** programme. Repeatedly pressing the PRG key, you can scroll through all the previously loaded values in sequence. After 1 minute's keyboard inactivity, the programming display procedure is automatically abandoned.

To stop the display, press the ENT key.

NOTES ON SCAN AND MAN FUNCTIONS

During the SCAN and MAN modes, the operation of the FO 935 can be displayed.

1) RUN cPU:

This message appears upon ignition of the device.

2) Ech Err:

This message appears when damage in the EEPROM memory is detected.

Pressing Reset will cancel the message and restore the original default parameters, listed in the programming paragraph on pages 19-20 return the control unit to TECSYSTEM for repairs.

3) TEC err: this message appears when a loss of communication is detected between the thermometric control unit and the CFO 521 concentrator. The temperatures shown on the display all appear at 0°C.

4) FO Err: this message appears when it is detected that one or more FO sensors are not working correctly **FCC, FOC** and **FLT**, signals, see sensor diagnostics on page 17.

In case of **Err** the FAULT relay will be de-energised.

The above messages will be displayed following the 1-2-3-4 priority stated.

LED TEST

We suggest carrying out the control unit LED test regularly.

For this operation, press the TEST key briefly; all the displays turn on for 2 seconds.

If one of the LEDS does not work, please return the control unit to TECSYSTEM for repair.

ALARM RELAY TEST

This function allows you to carry out a test of the relays operation without having to use further devices. To start the test procedure, press and hold the TEST button for approximately 5 seconds: the TST indication appears for 2 seconds confirming entry into the Relays Test mode.

The lit LED indicates the relays to be tested, use the cursors ▲▼ to select the desired relay.

Press the SET and RESET keys to energise and de-energise the relay to be tested; the display will show ON-OFF.

After 1 minute's keyboard inactivity, the RELAY TEST procedure will be automatically abandoned.

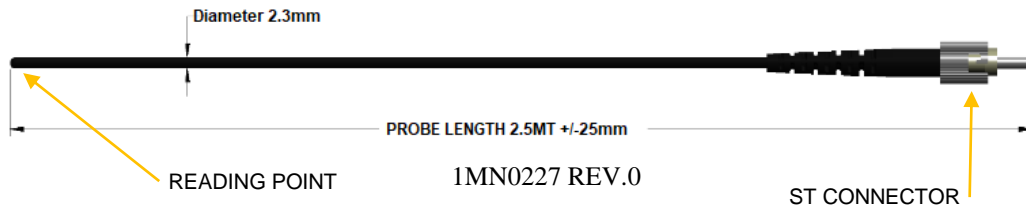
To stop the RELAY TEST procedure, press the TEST key.

ATTENTION: entering the relay test mode will temporarily disable the fail-safe function, relays with enable function switch (ALARM-TRIP-FAULT).

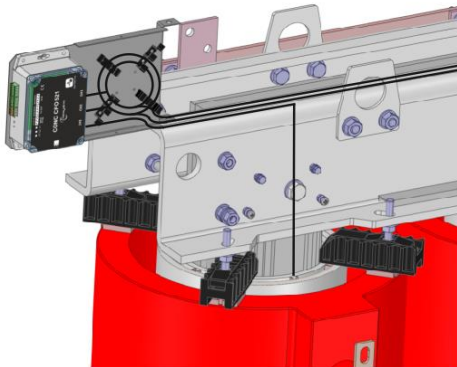
ALARM RELAY SILENCING

To silence the ALARM signal, press the RESET key: the relay will de-energise and the ALARM LED, which is on steady, will start to flash. Silencing is automatically disabled when the temperature goes below the ALARM threshold.

FO (FIBRE OPTIC) TEMPERATURE SENSOR DIMENSIONS/INSTALLATION



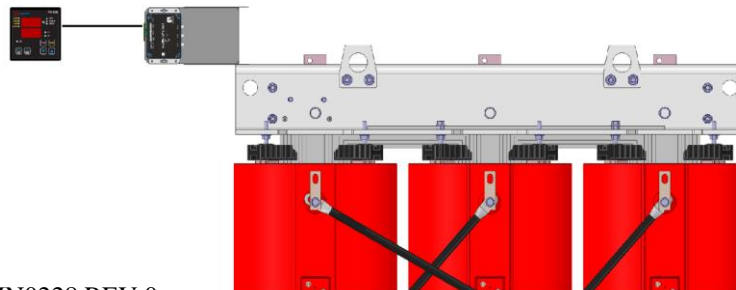
The FO sensors must be inserted inside the secondary winding of the transformer always respecting the following indications:



1MN0228 REV.0

- each sensor U-V-W must be inserted inside the secondary winding transformer, the sensor CH2 must be placed in the central column.
- insertion of the probe must not find any restrictions or occlusions of any kind;
- avoid twisting, straining or jerking. The fibre sensors could be damaged;
- the connection of the sensors to the CFO 521 concentrator must be laid linearly, with a maximum radius of curvature of 8mm, not less than 90°;
- the connection of the sensors to the CFO 521 concentrator must be made with the original ST connector supplied with the sensor.
- any excess of the probes must be wound with a minimum diameter of 50mm, using the winder located on the mounting bracket;
- once the probes have been installed, apply the protection bracket using the M4 screws supplied.

CONNECTION OF THE CONC. CFO 521 / TO THE FO 935 CONTROL UNIT



1MN0228 REV.0

Connect the FO IN input of the CFO521 concentrator to the FO IN input of the FO 935 control unit, respecting the numbering **B1-B2-B3-B4**.

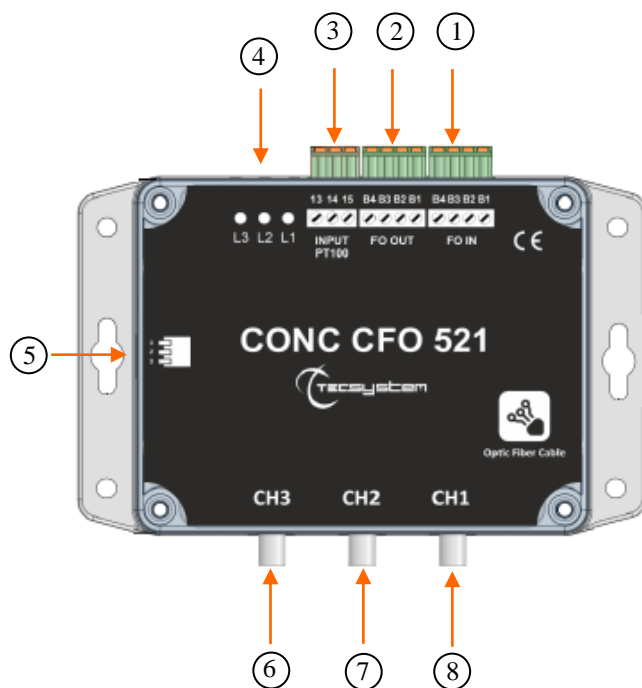
The FO OUT output is not used (provision for future development).

The CFO 521 concentrator is powered by the FO 935 control unit, through the FO IN B1-B2-B3-B4 connection bus, therefore it does not require an external power supply.

For correct connection of the CFO 521 concentrator to the thermometric control unit, the following rules must be strictly observed:

Note: All the signal transportation cables must strictly:

- be separated from those of power
- be created with shielded cable with twisted conductors
- have a section of at least 0.25 mm²
- the shield must be earthed on one side only
- be firmly fixed in the terminal blocks
- have tin-plated or silver-plated conductors



1MN0226 REV.0

1)	FO IN Input	5)	Dip-switch (not used)
2)	FO OUT output not used (Provision for future developments)	6)	CH3 fibre optic input
3)	CH4 2/3-wire Pt100 input	7)	CH2 fibre optic input
4)	L1-L2-L3 LED	8)	CH1 fibre optic input

CFO 521 CONCENTRATOR OPERATION

The CFO 521 device electronically acquires and converts the temperatures detected by the FO sensors CH1-CH2-CH3 and CH4 (Pt100) and sends the detected data to the FO 935 monitoring unit via the TEC digital communication bus.

The FO (fibre optic) temperature sensors must be connected to the CH1-CH2-CH3 inputs arranged in the three phases of the U-V-W transformer. For a correct interpretation of the measured values it is advisable to combine the CH2 probe with the central phase V.

The CFO 521 concentrator has a Pt100 input, RTD class A 2/3-wire probe, for the possible connection of a probe on the core of the transformer or application of an ambient probe (CH4).

The connection of the Pt100 probe must be 13- White - 14 Red - 15 Red.

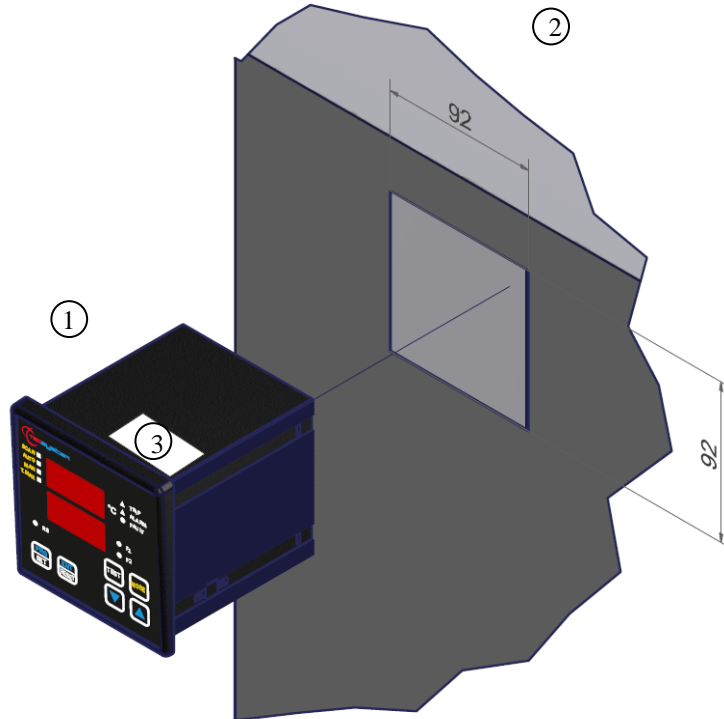
The dip-switch must be 000

The LEDs indicate the operating status of the concentrator and of the connected sensors:

- all LEDs OFF signal the lack of power supply on the CFO 521 device.
- Single or multiple LEDs flashing: L1-L2-L3, single flashing every 2 seconds, indicates the correct functioning of channel CH1-CH2-CH3.
- Single or multiple flashing LEDs: L1-L2-L3, double flashing every 2 seconds, indicates incorrect operation of the reference channel of channel CH1-CH2-CH3.

FO 935 ASSEMBLY

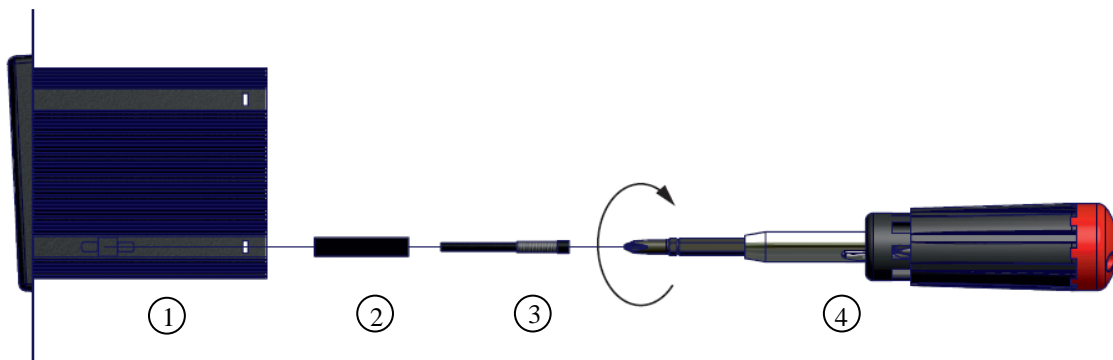
Drill a hole in the panel sheet with dimensions of 92 x 92 mm.



1MN0007 REV.0

1)	Control unit	2)	Panel hole dimensions (+0.8 mm tolerance)
3)	Identification label		

Secure the appliance firmly by means of the supplied fixing blocks.

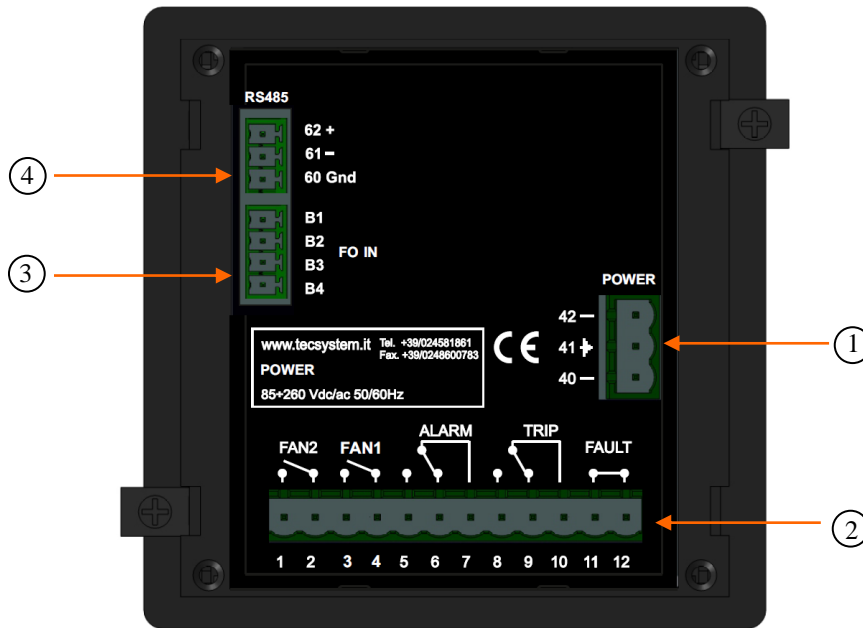


1MN0008 REV.0

1)	Control unit	3)	Fixing screws
2)	Fixing blocks	4)	Cross-head screwdriver #1X100mm

ELECTRICAL CONNECTIONS

FO 935 D

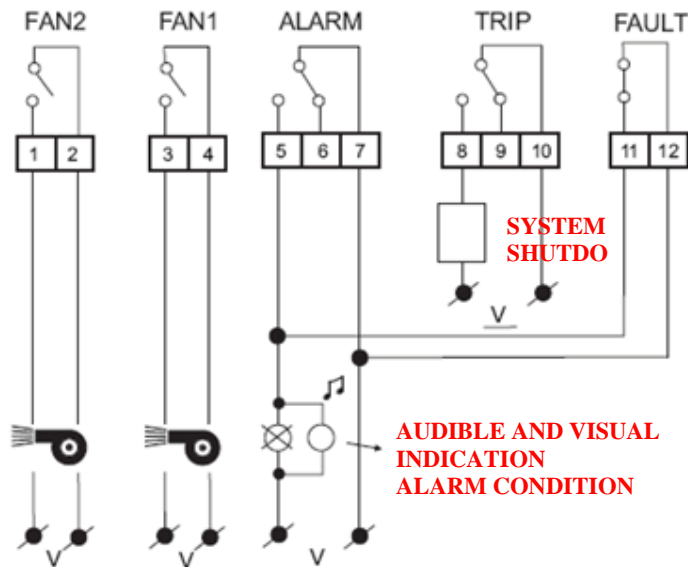


1MN0225 REV.0

1)	Power supply 85-260Vdc-ac 50/60Hz	3)	FO IN bus input for connection to the CFO 521
2)	Relay (ALARM-TRIP-FAULT-FAN1-FAN2)	4)	RS485 Modbus Inside RTU output

Note: image relay contacts in non-alarm condition, except for the FAULT relay which switches: contacts 10–11 closed (NO) contacts 9-11 open (NO) fault condition identification. Read paragraph Alarms and Ventilation p. 17 and see image of fault contact switching.

RELAY CONNECTION EXAMPLE



Output relays with 10A-250Vca-res COS Φ =1 contacts

1MN0095 REV.0



ATTENTION: Before carrying out any electrical test on the transformer or on the panel, e.g. dielectric strength etc., it is advisable to disconnect all the components of the FO system. Any noise or voltage peaks on the inputs or on the power supply could cause the failure of: sensors, concentrator or control unit.

POWER SUPPLY

The FO 935 control unit can be supplied by 85 to 260 Vdc-Vac, 50/60 Hz irrespectively of polarity in Vdc (terminals 40 - 42).

This particularity is obtained thanks to the use of a tested power supply, of new conception and realisation, which frees the installer from any uncertainty regarding the correct Vac or Vdc power supply.

The earthing cable must always be connected to terminal 41.

When the control unit is powered directly by the secondary of the transformer to be protected, it can be burnt out by high intensity overvoltages.

These problems occur if the main switch is closed and the transformer does not have the load (no load test).

The above is much more evident when the 220 Vac voltage is taken directly from the bars of the secondary of the transformer and there is a fixed capacitor battery for power factor correction of the transformer itself.

To protect the control unit against line overvoltages, the PT-73-220 electronic arrester, designed by TECSYSTEM S.r.l. for this specific purpose, is recommended. Alternatively, it is advisable to use power supply voltages 110 Vac or, even better, 110 Vdc.

If an existing control unit must be replaced with a new one, to guarantee its correct and safe operation, the sensor/relay/supply connecting terminals must be replaced with the new terminals supplied.

ALARMS AND VENTILATION

Carry out the electrical connections on the removable terminal blocks only after disconnecting them from the unit.

When the control unit is in one of the modes indicated below it does not perform any thermal monitoring, moreover the relays will all be disabled. The fault contact switches and the fault LED flashes.

- Programming viewing display.
- PRG programming.
- Relay test.

The ALARM and TRIP relays only switch when the set temperature thresholds are exceeded.

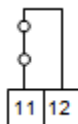
The FAULT (fault) contact, programmed in active failsafe mode (default YES), opens (11-12) when the appliance is powered, only if during the access phase the control unit does not detect anomalies, and keeps the switching until when one of the following events occurs:

- Data memory fault (Ech message).
- FO sensor fault (FCC-FOC-FLT)
- CFO 521 concentrator disconnected (TEC)
- Insufficient supply voltage.
- During the power on reset after programming (PRG), displaying of the data (VIS) and relay test.

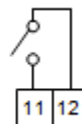
The FAULT failsafe mode can be disabled FAULT failsafe "NO" see programming step 30-31 page 20.

NOTE: in order to avoid unwanted system outages, do not connect the FAULT relay to the transformer tripping circuit.

FAULT CONTACT OPERATION (failsafe active)



FAULT 11-12 NC: ALARM FAULT OR POWER OFF



FAULT 11-12 NO: POWER ON OR NO FAULT

The FAN1 and FAN2 contacts can be used to control the cooling fans, or they can be inserted in the conditioning system of the transformer room, see paragraph cooling fan control on page 18.

NOTE: always disconnect the unit before performing any electrical connections.

FAULT AND RESET MESSAGE SEQUENCE

Find below the sequence of fault messages and RESET function condition.

1) ECH	eprom fault	erasable message
2) TEC	concentrator communication bus fault	non-resettable condition
3) FO FCC	min. temperature full scale exceeded	non-resettable condition
4) FO FOC	max. temperature full scale exceeded	non-resettable condition
5) FO FLT	broken or disconnected fibre optic sensor	non-resettable condition

FO SENSOR DIAGNOSTICS

In case of breakage or exceeding of the minimum/ maximum full scale value of one of the FO sensors installed on the machine to be protected, the FAULT relay is instantaneously switched, with the relative sensor failure indication on the corresponding channel.

Display message **FCC**: exceeding of the minimum full scale value = measured temperature < -35°C

Display message **FOC**: exceeding of the maximum full scale value = detected temperature > 195°C

ATTENTION: the FLT indication appears on the display when the concentrator identifies a faulty or disconnected FO sensor.

To eliminate the message and to restore the Fault switching, check the connections of the FO sensors and replace the faulty sensor if necessary. In case the minimum/maximum full scale value has been reached, make sure that the environmental conditions correspond to what is indicated by the control unit.

Note: exceeding of the minimum/ maximum full scale can also be caused by possible disturbances on the communication lines or by strong magnetic fields; in this case, the following is recommended:

Check the correct installation of the sensors and especially of the extension cable between the CFO 521 concentrators and the FO 935 control unit.

PROGRAMMED DATA DIAGNOSTICS

In case of failure of the internal memory or corruption of programmed data, just after switching on, **Ech** appears with the relevant Fault contact signal.

In this case, for safety reasons, the default parameters are loaded automatically (see programming table on pages 19-20).

Eliminate the **Ech** indication by pressing RESET and run programming to enter the desired values.

Finally switch the unit off and back on to check the memory works correctly, if it is damaged **Ech** will be displayed again (send the control unit to TECSYSTEM srl for repairs).

TEMPERATURE DIAGNOSTICS

When one of the sensors detects a temperature higher than 1°C with respect to the pre-set value as the alarm limit, after approximately 5 seconds the **ALARM** relay switches and the channel **ALARM** LED (CH n) switches on.

When the trip temperature limit is exceeded, after approximately 5 seconds the **TRIP** relay switches and the channel **TRIP** LED (CH n) switches on.

As soon as the recorded temperature returns to values equal to or lower than the limit set for the **ALARM** and **TRIP** relays switching, these relays de-energise and the corresponding LEDs switch off.

The values of **ALARM** and **TRIP** are kept in the internal memories: they can be recalled by entering the Vis modes (displaying programmed parameters) and modifiable in the PRG mode (programming).

COOLING FAN CONTROL

The FO 935 control unit is fitted with two FAN contacts (FAN1 and FAN2) and, if programmed correctly, can control the fans switching ON and OFF to cool the transformer.

The FAN1 and FAN2 contacts can manage cooling the transformer and the room where it is installed.

Connecting FAN1 to the tangential ventilation system (the two bars located on the transformer) and FAN2 to the extractor will improve the air flow in the cabin; furthermore, the cabin temperature will no longer need to be managed by a thermostat that is external to the system.

The fans can be controlled in two different ways:

- Using the temperatures sensed by the sensors on the three columns
CHF 1.2.3 (e.g.ON at 70°C - OFF at 60°C)
- Through an additional sensor (**CH4/YES**) dedicated to the ambient temperature inside the transformer room.
CHF 4 (e.g.ON at 40°C - OFF at 30°C)

The ON and OFF values are programmable according to the device range. The FAN ON must always be at least 1°C higher than FAN OFF (recommended ΔT FAN ON_OFF +10°C).

The FAN 1/ 2 LED lights up when the temperature exceeds 1°C, the FAN ON threshold, the corresponding relay switches, and turns off when the temperature goes below 1°C the FAN OFF threshold, the corresponding relay switches.

FAN TEST

It is possible, by programming (**HF_n**), to make sure that the fans are operated for 5 minutes every xxx' hours, regardless of the temperature values of the columns or the environment (e.g.: with HF_n = 001 the fans are activated for 5 minutes every hour).

This function is designed to periodically check the operation of the fans and of their control equipment.



















Setting **NO**, this function is inhibited.

To enable the HF_n function, read the programming section on pages 19-20.

PROGRAMMING

FO 935 D

STEP	PRESS	EFFECT	PRESS	NOTES
1		Press and hold the PRG button until the display shows SET PRG		
2		Select PRG SET to proceed with programming or PRG 1 to load the default values	 	PRG 1 default data
3		The ALARM threshold for (CH 1-2-3) is displayed. Set the desired threshold, the Alarm LED flashes	 	Default 90°C
4		The TRIP threshold for (CH 1-2-3) appears and the Trip LED flashes.		
5		Set the desired threshold	 	Default 119°C
6		CH 1-2-3 is displayed The Fan1 LED flashes		Default YES
7		Select YES/NO	 	
8		The display shows (CH4) Enabling CH4		
9		Select YES or NO	 	with YES the CH4 is enabled with NO the CH4 is disabled
10		The ALARM threshold for (CH4) appears and the Alarm LED flashes.		If CH4=NO jump to step 16, Default NO
11		Set the desired threshold	 	Default 120°C
12		The TRIP threshold for (CH4) is displayed. The TRIP LED flashes		
13		Set the desired threshold	 	Default 140°C
14		The display shows FAN 2 for (CH4)		Default Yes
15		Select YES/NO	 	
16		The display shows ON (CH 1-2-3), the FAN1 LED flashes		Default 70°C
17		Set the desired threshold FAN1 ON	 	If FAN1 NO is selected skip to step 21
18		The display shows OFF (CH 1-2-3), the FAN1 LED flashes		Default 60°C
19		Set the desired threshold FAN1 OFF	 	

20		The display shows ON (CH4), the FAN 2 LED flashes		Default 45°C
21		Set the desired threshold FAN2 ON	 	If FAN2 NO is selected skip to step 24
22		The display shows OFF (CH4) the FAN2 LED flashes		Default 35°C
23		Set the desired threshold FAN2 OFF	 	
24		HFN (NO) is displayed The FAN1-FAN2 LEDs flash		Fan cyclic test for 5 min. every "n" hours
25		Set the desired number of hours	 	Default NO = function disabled
26		FLS (ALARM) is displayed Blinking ALARM LED (FAIL SAFE info on page 21)		
27		Select YES or NO	 	Default NO
28		FLS (TRIP) is displayed Blinking TRIP LED		
29		Select YES or NO	 	Default NO
30		FLS (FAULT) is displayed Blinking FAULT LED		
31		Select YES or NO	 	Default YES
32		ADR <=>"datum" is displayed		Modbus address Default 001
33		Set the address	 	1 to 255
34		BDR <=>"datum" is displayed		Modbus transmission speed Default 19.2 Kb/s
35		Set the desired speed	 	From 2.4 Kb/s to 38.4 Kb/s
36		PAR <=>"datum" is displayed		Parity bit selection. EVE Default
37		Set the desired parity bit	 	None (N-1 or N-2), Even (EVE), Odd (ODD) See frame DATA on page 22.
38		END is displayed		End of programming;
39		Press ENT to save the set data and exit programming		incorrect programming of the LED values indicated (note 6)
40		Return to step 1		See programming notes p. 21



ATTENTION:

We recommend you check the device's programming before starting the device.

The default parameters set by TECSYSTEM might not match your requirements.

Programming the device is the end user's responsibility. The settings of the alarm thresholds and enabling of the functions described in this manual must be checked (by a specialist engineer) according to the application and features of the system the control unit is installed on.

PROGRAMMING NOTES

- 1) The MODE key allows reversing the programming steps according to the sequence 28-8-3.
- 2) The TEST key allows exiting programming without saving the modified data.
- 3) After 1 minute's keyboard inactivity programming is abandoned without saving the data.
- 4) During programming the control unit does not control/protect the monitored machine.
- 5) At the end of programming the control unit is restarted and the FAULT relay is disabled until the unit is fully restarted.
- 6) If pressing ENT, "Err" appears, it means that one of the following mistakes has been made:

ERR ALL= ALARM \geq TRIP

ERR FAN = FAN-OFF \geq FAN-ON (FAN1 OR FAN2)

The device automatically prepares itself for the programming step of the error committed

NOTE: EVERY TIME THE CONTROL UNIT PROGRAMMING, WITH CONFIRMATION OF DATA SAVING, THE VALUES STORED IN T-MAX ARE RESET AT THE TIME OF STORING.

FAIL-SAFE FUNCTION

The FO 935 control unit has the selection n.o (normally open contact) / n.c (normally closed contact) for the ALARM, TRIP and FAULT relays, programming steps from 26 to 31 page 20. Selecting the YES/NO setting introduces the Fail Safe and No Fail Safe functions.

ALARM AND TRIP

By setting NO (NO Fail safe) the normally open contacts are in positions 5-7 Alarm and 8-10 Trip, they switch only when the pre-set temperature limits are reached.

By setting YES (Fail safe), the normally closed contacts are in positions 5-7 Alarm and 8-10 Trip, they switch only when the pre-set temperature limits are reached or as a result of no voltage on the device.

FAULT

By setting YES (Fail safe), contact 11-12 is positioned as normally open, switches (closed) when a fault condition is identified; see paragraph on alarms and ventilation on page 17.

Setting NO (NO Fail safe) the contact 11-12 is positioned as normally closed, switches (open) when a fault condition is identified; see paragraph on alarms and ventilation on page 17.

If the failsafe function is disabled on the fault contact, the control unit will no longer be able to signal the fault due to power failure. In this case it is advisable to enable the failsafe on the ALARM contact for the afore-mentioned indication.

NOTE: when the control unit is in one of the modes indicated below, it does not perform any thermal monitoring, moreover the relays will all be disabled the FAULT LED will flash.

- Vis. display programming.
- PRG programming.
- Test of the relays.

The FAILSAFE function is temporarily disabled and the FAULT relay switches.

ATTENTION: entering the relay test mode will temporarily disable the fail-safe function, relays with enable function switch (ALARM-TRIP-FAULT).

OUTPUT RS485 MODBUS

INTRODUCTION TO THE MODBUS INSIDE MODULE

The MODBUS INSIDE expansion module is built in the monitoring unit and allows data transfer on a RS485 line with MODBUS RTU protocol, maximum 32 devices.

OPERATING NOTES

For the module to work correctly, it is necessary to set the RS485 network set-up parameters: address, baud rate, parity bit.

See programming steps 32 to 37 on page 20.

The serial communication of the temperature control monitoring unit is active only when the FO 935 D is in temperature control mode in one of the intended modes (Scan, Auto, Man and T.Max).

When other functions such as programming, programming display and relay test are activated, the ModBus communication is temporarily deactivated.

DATA TRANSMISSION ON MODBUS NETWORK

The internal MODBUS INSIDE module is used to connect the FO 935 D control unit to an RS485 network with Modbus RTU protocol in order to read the data indicated in the modbus table, page. 25, and to be able to write those indicated in the notes section for remote programming, the module is always in slave mode.

The FO 935 D control unit is in communication with the network only when it is in temperature reading mode, while it is inactive when in the following modes: display, programming and test relays.

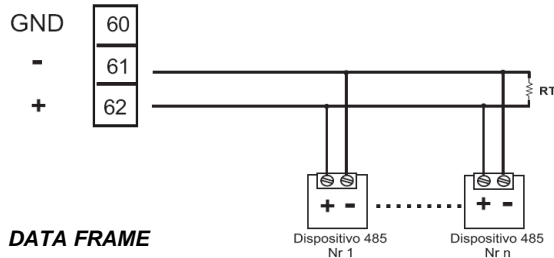
RS485 ELECTRICAL CONNECTIONS

As far as the signal cable to be used in order to ensure the correct network operation is concerned, we recommend you follow the provisions of the EIA RS485 standard which suggests using a 24AWG twisted pair.

The twisted pair that connects units in RS485 might need a 120 ohm end resistor on the last unit of the series.

Connect the twisted pair paying attention to polarities and lay the network avoiding to make sharp bends or ring windings in order not to modify line impedance. If necessary, the GND terminal for grounding is also available.

Always position the RS485 twisted pair far from power cables.



1MN0095 REV.0

DATA FRAME

The frame in asynchronous transmission consists of: 1 start bit, 8 data bits, 1 parity bit (even or odd, if the parity has been set) and 1 stop bit.

With parity NO (none) it is possible to select N-1 (1 stop bit) or N-2 (2 stop bit).

The permitted baud rates are: 2400, 4800, 9600, 19200 and 38400.

If not otherwise specified, the word length (DATA) is 16 bits.

DATA PACKET

A complete request/response sequence is composed as follows:

Master's request:

SLAVE ADDRESS	- 1 byte
FUNCTION CODE	- 1 byte
DATA	- variable, depends on the function code
CRC	- 2 byte

Slave request:

SLAVE ADDRESS	- 1 byte
FUNCTION CODE	- 1 byte
DATA	- variable, depends on the function code
CRC	- 2 byte

FUNCTION CODE

The ModBus module supports the following function codes:

- 3₍₁₀₎**: holding register reading
- 16₍₁₀₎**: multiple registers writing

If ModBus receives a message and a CRC error is detected, no answer is given.

CODE 3₍₁₀₎

Request:

Slave address, code 3₍₁₀₎, Starting address HI, Starting address LO, Number of Point HI, Number of Point LO, Crc LO, Crc HI.

Response:

Slave address, code 3₍₁₀₎, Byte count, Data HI, Data LO....., Crc LO, Crc HI.

CODE 16₍₁₀₎

Request:

Slave address, code 16₍₁₀₎, Starting address HI, Starting address LO, Number of Point HI, Number of Point LO, Byte count, Data HI, Data LO....., Crc LO, Crc HI.

Response:

Slave address, code 16₍₁₀₎, Starting address HI, Starting address LO, Number of Register HI, Number of register LO, Crc LO, Crc HI.

NOTES FOR REMOTE PROGRAMMING

The writeable registers are shown in TABLE MODBUS MAPPING referred to as W or RW (**write or read/write**). max number of registers 72, see table pages 25-28.

Channels 1÷3 cannot be disabled; in case of incorrect setting they are always forced as enabled channels.

In the case in which the channel 4 is not enabled and/or the information is not provided we have the following answers:

1. **Measured temperatures** = 0000 (0°C)
2. **Temperature AL./TRIP = Value written in E2PROM**
3. **Channel status** = 0000
4. **Channel setting** = %00000000; %xxxxxxx0 (x=n.d.)

In the event that information is sent in writing to a register can't be written (only READ) data will be trashed without affecting the received message.

Also in the remote programming phase via ModBus it must be considered that the Alarm thresholds must be lower than the Trip thresholds and that the Fan-on thresholds must be higher than the Fan-off thresholds.

In case you try to set these thresholds incorrectly, the control unit FO 935 D will not proceed with the programming and storage of data, therefore in subsequent readings will read the data from the previous schedule.

After having sent a request for writing the control unit will take a time of about 1 " to store the data in eeprom, during the step of storing the module ModBus will not be able to process additional requests.

If the demand for programming is successful, the unit automatically resets and loads the new settings.

The information "RELAY STATUS" indicates the state of excitation of the coils of the relays, so it will be subject to the commands of "FAIL SAFE".

At the end of the write command (Write) is carried out a check of compatibility data:

1. **If you have a non-compatibility "exception" for an answer and the data packet is rejected in its entirety. The code of the first erroneous data can be obtained by reading the log "Error received data".(NB: this code is lost during RESET or new power or writing data in E2PROM);**
2. **if the data are correct, they are transferred to the non-volatile memory (E2PROM), the historical data is reset (Tmax = 0°C) and a reset of the system is subsequently forced**
3. **If the WRITE command implies only writing "COMMANDS" it will be implemented autonomously and without RESET, i.e. without affecting the data of the control unit.**

ERROR CODES (exception codes)

In case of a wrong request, ModBus will answer with modified codes and codified errors according to the following:

- 1: Unsupported function code
- 2: Wrong data address
- 3: Wrong data (for instance length)

The memory area containing the HFN datum must undergo no forcing.

In the case in which all the fans are turned off (FAN1, FAN2) the test of the relay will not take place.

UNACCEPTABLE DATA

There are some programmings that are not acceptable as they are not foreseen by the FO 935 D instrument; such data will be discarded without producing any error message (EXCEPTION CODE).

- CH 1-2-3:→ channels that cannot be disabled
- CH 1-2-3: → FAN_2 cannot be enabled
- CH4 → FAN_1 cannot be enabled
- CH4 → FAN_2 cannot be enabled if CH 4 = no

ILLEGAL DATA

On the other hand, some combinations are programming errors because they are wrong settings; in this case the error code is ILLEGAL_DATA. This information is accessible to ModBus reading the register 7.

NO ERROR	No error 00
CH_1 Trip ≤ Alarm	Error code 01
CH_4 Trip ≤ Alarm	Error code 04
FAN_1 ON ≤ OFF	Error code 017
FAN_2 ON ≤ OFF	Error code 018
Value HFN > max see table: SYSTEM - Setting and Status	Error code 020

CONTROL UNIT GENERAL NOTES

The various models of the control units can be equipped with different options; to avoid disruption of production, their existence is defined by Fw indicated power, with messages dedicated on display LEDs.

This information can be accessed by reading the Modbus register 6 (option) with the following meaning:

LOW Byte

Bit_0 = D:RS485 Modbus

HIGH Byte

Bit_0/1 = 10 - Range -35°C ÷ 195°C

Note; in case the values programmed from ModBus are out of range, a date "exception" error response will be generated.

POLLING FREQUENCY.

It is advisable to adopt polling frequencies greater than or equal to 1 second.

Pollings can frequently overload the system, without bringing any benefit. In multi-device RS485 lines, interrogated in sequence, it may be useful to enter a delay between polls in relation to: the number of connected devices, the communication speed and the number of registers read.

MODBUS MAPPING TABLE

HEADER (information and commands):

Address LO ⁽¹⁰⁾	Data HI	Data LO	W: write W:write W: read/write
1	Model – MSD (ASCII)	Model - 3rd Digit (ASCII)	R
2	Model - 2nd Digit (ASCII)	Model – LSD (ASCII)	R
3	Space (20H)	Vers.Fw – MSD(ASCII)	R
4	Vers.Fw - 2nd Digit (ASCII)	Vers.Fw – LSD(ASCII)	R
5	Qty channels (2*ASCII)		R
6	Options (see notes)	Options (see notes)	R
7	00	Incorrect datum received	R-see tab.
8	00	Info various causes	R-see tab.
9	00	Controls	W-see tab.

SYSTEM: Setting and Status

Address LO ⁽¹⁰⁾	Data HI	Data LO	Notes 1	Notes 2	W: write W:write W: read/write
10	00	HFN (Fan test)	0=No test	1÷200h	RW
11	00	00	FREE	See Note	R
12	00	00	FREE	See Note	R
13	00	CPU Setting	See Notes		RW
14	00	CPU Error	See Notes		R
15	00	Status Relay	See Notes		R
16	00	00	FREE	See Note	R

17	00	Address	Modbus address	1÷255	R
18	00	Bdr	Modbus baud rate	0=2400 1=4800 2=9600 3=19200 4=38400	R
19	00	Parity	Modbus parity bit	0=N-1 None+1Stop 1=Even 2=Odd 3=N-2 None+2Stop	R
20	00	FREE	See Note		R

TEMPERATURE FANS:

Address LO ₍₁₀₎	Data HI	Data LO	Notes 1	Notes 2	W: write W:write W: read/write
21	2'compl. sign	Fan_1 ON	1°C ÷ 190°C		RW
22	2'compl. sign	Fan_1 OFF	1°C ÷ 190°C		RW
23	2'compl. sign	Fan_2 ON	1°C ÷ 190°C		RW
24	2'compl. sign	Fan_2 OFF	1°C ÷ 190°C		RW

TEMPERATURES channels 1÷4:

Address LO ₍₁₀₎	Data HI	Data LO	Notes 1	Notes 2	W: write W:write W: read/write
25	2'compl. sign	2'compl.Ch1 temper.	-35°C ÷ 195°C		R
26	2'compl. sign	2'compl.Ch1 max temperat.	0°C ÷ 195°C		R
27	2'compl. sign	2'compl.Ch1 temper. alarm set point	1°C ÷ 190°C	AL	RW
28	2'compl. sign	2'compl.Ch1 temper. trip set point	1°C ÷ 190°C	TRP	RW
29	2'compl. sign	2'compl.Ch2 temper.	-35°C ÷ 195°C		R
30	2'compl. sign	2'compl.Ch2 max temperat.	0°C ÷ 195°C		R
31	2'compl. sign	2'compl.Ch2 temper. alarm set point	1°C ÷ 190°C	As (AL)	R
32	2'compl. sign	2'compl.Ch2 temper. trip set point	1°C ÷ 190°C	As (TRP)	R
33	2'compl. sign	2'compl.Ch3 temper.	-35°C ÷ 195°C		R
34	2'compl. sign	2'compl.Ch3 max temperat.	0°C ÷ 195°C		R

35	2'compl. sign	2'compl.Ch3 temper. alarm set point	1°C ÷ 190°C	As (AL)	R
36	2'compl. sign	2'compl.Ch3 temper. trip set point	1°C ÷ 190°C	As (TRP)	R
37	2'compl. sign	2'compl.Ch4 temper.	-35°C ÷ 195°C		R
38	2'compl. sign	2'compl.Ch4 max temperat.	0°C ÷ 195°C		R
39	2'compl. sign	2'compl.Ch4 temper. alarm set point	1°C ÷ 190°C	AL	RW
40	2'compl. sign	2'compl.Ch4 temper. trip set point	1°C ÷ 190°C	TRP	RW
41	00	00			R
42	00	00			R
43	00	00			R
44	00	00			R
45	00	00			R
46	00	00			R
47	00	00			R
48	00	00			R
49	00	00			R
50	00	00			R
51	00	00			R
52	00	00			R
53	00	00			R
54	00	00			R
55	00	00			R
56	00	00			R

CHANNELS 1-4:Setting

Address LO (10)	Data HI	Data LO	Notes 1	Notes 2	W: write W:write W: read/write
57	00	Ch1 Setting	See Notes CHx		RW
58	00	Ch2 Setting	See Notes CHx		R
59	00	Ch3 Setting	See Notes CHx		R
60	00	Ch4 Setting	See Notes CHx		RW
61	00	00	--		R
62	00	00	--		R
63	00	00	--		R
64	00	00	--		R

CHANNELS 1-4:Status

Address LO (10)	Data HI	Data LO	Notes 1	Notes 2	W: write W:write W: read/write
65	Ch1 story	Ch1 status	See Notes CHx		R
66	Ch2 story	Ch2 status	See Notes CHx		R
67	Ch3 story	Ch3 status	See Notes CHx		R
68	Ch4 story	Ch4 status	See Notes CHx		R
69	00	00	--		R
70	00	00	--		R
71	00	00	--		R
72	00	00	--		R

REGISTERS NOTES

INFO various causes (READ)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	--	-	-	-	-	(*) RESET (R) has taken place

COMMANDS (WRITE)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	--	-	-	Reset Reg.CPU_ERROR	(*) Reset historical data	(*) ResetBIT: RESET has taken place

CHn SETTING

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	--	--	--	FAN2	FAN1	CAN_enabled

CHn STATUS

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	TRIP	ALARM	FAN_2	FAN_1	FLT	FOC	FCC

CHn STORY

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	TRIP	ALARM	--	--	FLT	FOC	FCC

RELAY STATUS (coil energising status)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	--	FAULT Relay 1=ON	TRIP Relay 1=ON	ALARM Relay 1=ON	FAN_2 Relay 1=ON	FAN_1 Relay 1=ON

CPU ERROR

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	TEC ERR	--	FO FLT	--	--	ECH

CPU SETTING

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
--	--	--	Failsafe fault	Failsafe trip	Failsafe alarm	--	--

WARRANTY REGULATIONS

The purchased Product is covered by the manufacturer's or seller's warranty under the terms and conditions indicated in the "Tecsystem s.r.l. General Sales Conditions", which can be consulted on the website www.tecsystem.it and/or in the stipulated purchase contract.

The warranty is considered valid only when the product is damaged by causes attributable to TECSYSTEM srl, such as manufacturing or components defects.

The warranty is invalid if the Product proves to have been tampered with/modified or incorrectly connected and causing voltages outside the set limits and does not comply with the technical data for use and assembly, as described in this instruction manual.

The warranty is always ex Corsico as stated in the "General Conditions of Sale".

TROUBLESHOOTING	<i>CAUSES AND SOLUTIONS</i>
The control unit does not switch on and the supply to terminals 40-42 is correct.	Check that: the connector is firmly inserted in its place the connection wires are tight and that there are no obvious signs of burns on the connectors. Turn off the power supply and carry out the above instructions, restore the voltage.
CH4 is in FAULT (FOC)	Programming error of the CH4 / YES control unit. Check and repeat the programming on page 19-20 select CH4 /NO.
One of the three/four channels is in FAULT (FOC-FCC-FLT)	Display message FCC : exceeding of the minimum full scale value = measured temperature < -35°C Display message FOC : exceeding of the maximum full scale value = detected temperature > 195°C Display message FLT : Sensor disconnected or faulty. Check the state of operation of the FO sensors
When turned on, the indication (ECH) appears	A strong disturbance has damaged the memory data. See the paragraph for programmed data diagnostics on page 18.
The indication FAULT (TEC) is displayed	CONC. 521 is disconnected it is advisable to check the connection between the CONC. 521 and the control unit FO 935.
Contact the TECSYSTEM Technical Department if the problem persists.	

EQUIPMENT DISPOSAL

The European directive 2012/19/EU (WEEE) has been approved to reduce the waste of electrical and electronic appliances and to encourage the recycling and reuse of materials and components of these appliances, thereby reducing the disposal of harmful residues and compounds originating from electrical and electronic material.



All the electrical and electronic equipment supplied after 13 August 2005 is marked with this symbol, pursuant to European directive 2012/19/EU on electrical and electronic waste (WEEE). Any electrical or electronic equipment marked with this symbol must be disposed of separately from normal domestic waste.

Returning of used electrical appliances: contact TECSYSTEM or the TECSYSTEM agent to receive information on correct disposal of the appliances.

TECSYSTEM is aware of the impact its products have on the environment and asks its customers active support in the correct and environmentally-friendly disposal of its devices.

USEFUL CONTACTS

TECHNICAL INFORMATION: ufficiotecnico@tecsystem.it

COMMERCIAL INFORMATION: info@tecsystem.it

